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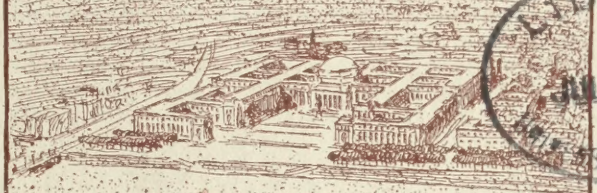

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May 1916 Vol. III, No. II

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GARDNER AND THE VESTAL VIRGINS

THE TECHNOLOGY MONTHLY
AND HARVARD ENGINEERING JOURNAL

VOL. III BOSTON, MASS., MAY, 1916 NO. 2

THE SUBMARINE OF TODAY

By H. H. W. KEITH, M. I. T., '05
Assistant Professor of Naval Architecture Massachusetts, Institute of Technology

Editor's Note. Never before in the history of the world has the submarine played such an important part in warfare and one might say commerce. It has revolutionized movements on the high seas. In the future this craft promises to be more in the foreground than ever. Every man should, to some extent, know of the construction, running and general features of the submarine. The following article gives a splendid conception of the Submarine of Today.

SUBMARINE is the popular name for any boat which has the ability to travel beneath the surface of the water. The term "submersible" is also applied to this type of craft, and especially to foreign boats, although as used loosely, there is no distinction between the two terms. Technically, however, there is considerable difference between the two types of boats, and it is necessary to state this difference before their properties can be taken up.

The principal distinction between a submarine and a submersible is that the latter has better sea-going qualities. In fact, the tendency now, in this country, is to drop the term "submersible" and denote the two types as "coast defense submarines" and "sea-going submarines," both of which expressions are self-explanatory as regards sea-going qualities. Since, in a submersible, these are the more important, its form and construction must be quite different from those of a submarine.

In a submarine, the ability to travel submerged is the most important requirement, the speed and habitability being secondary considerations. For the first named requirement a single spindle-shaped hull of circular cross section is best adapted, not only to resist the water pressure, but for driving when submerged. Hence in the sea-going type of submarine we find, in general, the double-hull type of construction. The inner hull is made of such shape and strength as to withstand the water pressure, whereas the outer hull is made of such shape as may be best for surface speed, stability and sea-going properties. The space between the two hulls is flooded when it is desired to submerge the boat, thus serving the double purpose of applying the water pressure directly to the inner, or strength hull, and also affording a means of submerging the boat without taking up valuable internal space with large ballast tanks, as in the single hulled submarine. As soon as the ability to make extensive voyages at sea is required, surface speed and sea-going qualities become very important, necessitating a change in the form of construction of the boat. A hull having circular or elliptical cross sections does not meet the requirements for speed on the surface, and does not give the reserve buoyancy necessary for going to sea. Such a hull is best adapted to withstand the great water pressure, (100 pounds per square inch), to which the submarine may be subjected.

The early Holland type, the Electric Boat Company type, and the Lake type, all of which are American boats are examples of the single hull submarine of circular cross section having internal ballast tanks. The principal types of submersibles are the French Laubeuf type, the Italian Laurenti type, and the German Krupp type. In these boats, the Krupp type excepted, the entire water ballast is carried between the inner and outer hull.

The submersible is much more in evidence in foreign navies than our own. France has been building this type since 1907. Germany and Italy have adopted it exclusively, and England, Russia and Japan are putting it more and more into use. In the United States, the Electric Boat Company has built most of the submarines in the Navy. These are of the single-hulled type and suitable for coast defense. Congress, however, has recently authorized three large sea-going submarines which may be called submersibles. The M-1 now being built by the Electric Boat Company, is in reality a form of submersible. Thus the old submarine type is fast approaching the new and effective submersible, or sea-going type. It is believed that Great Britain has now at least 200 submarines of which 20 are submersibles of about 2,000 tons displacement.

The two principal classes of submarines are then, the sea-going, and coast defense submarines, the main point of difference being size. For the sea-going type the displacement should be about 1,200 to 1,400 tons for the submerged condition, whereas for the coast defense type, the displacement need only be 300 or 400 tons. The surface speed for the former should be from 20 to 25 knots, while for the latter, 14 or 15 knots is sufficient. The lengths may be about 275 and 150 feet respectively.

Two sizes of coast defense submarines may be used, depending upon the naval policy of the nation. Either a large number of small boats may be permanently stationed at different places along the coast, or a smaller number of larger boats, having better speed and sea-going qualities, may be stationed at fewer places and moved about as circumstances require. In view of the different ideas on this question, a compromise is generally made between the two types, resulting in a submarine which closely approaches the sea-going type. At present the requirements for coast defense submarines in the United States Navy are obtained with a surface displacement of about 500 tons.

As above stated, high speed and sea-going qualities are obtained only with increased size, and the power required to drive these boats increases rapidly with increase in speed. For example, it will require about ten times as much power to drive a 1,200-ton submarine at 25 knots as it does to drive a 300-ton submarine at 15 knots. The problem of providing the large power plant required for a high speed submarine thus becomes very serious. Internal space is extremely valuable in a submarine, and not only does power have to be furnished for driving the boat on the surface, but in addition, some means must be furnished for propelling the boat when it is submerged. So far, electric motors driven by storage batteries are the only satisfactory means for underwater propulsion. This is because any engine depending upon combustion for its motive power cannot work when the boat is submerged without using large quantities of air, and also having some provision for the disposal of the exhaust gases.

For driving the boat at moderate speeds on the surface the Diesel internal combustion engine offers the most satisfactory means of providing power. It is fairly compact, not very heavy, economical, can be started instantly, and when shut down does not radiate heat excessively as does a steam plant. At present a combination of these two methods of propulsion affords the best means for driving a small submarine at a moderate speed. But a plant of this type which would deliver the amount of power required to drive a large submarine at a speed of 25 knots, would require a prohibitive expenditure of weight and space, and would result in a very long boat. The reason for this is, that with the present development of the Diesel engine it is not possible to obtain over 200 or 250 horse-power in any one cylinder. To increase the power of these engines it is necessary to increase the number of cylinders. This naturally results in a long and heavy engine having a very great number of moving parts, and taking up much more space in a submarine than can be afforded. Individual cylinders cannot be indefinitely enlarged in a Diesel engine, or other internal combustion engine, for the reason that the pressures and temperatures resulting from the explosion of the fuel in the cylinder are tremendous, and the forces acting on large cylinder areas would set up stresses quite prohibitive in ordinary engine construction.

It may be that in the future this difficulty will be overcome, but at present, we are obliged to turn to some other means than the internal combustion engine to furnish the large powers required for the high-speed fleet submarine. For example, a 25-knot submarine of about 1,200 tons surface displacement would require about 10,000 horse-power. Assuming that twin screws are used, this would give 5,000 horse-power per shaft, and allowing 250 H. P. per cylinder, a 20-cylinder engine would be required. For triple screws, 14 cylinders would be necessary.

It seems obvious that for such powers as this, a steam plant will be necessary. The French are the pioneers in this field, and over 25 years ago they experimented with steam power plants for submarines. Then the question was not so much one of power as it was how to avoid the unreliability of the motor and storage batteries and the internal combustion engine. Finally, however, steam was abandoned in favor of the Diesel engine. No satisfactory substitute has yet been found for the storage battery and electric motor used when the boat is submerged, but for the surface condition, steam is soon liable to supersede the Diesel engine as a means of propulsion.

In the U. S. Navy gasolene engines are used in the A, B, C, D, and some of the G class submarines. These engines have given very satisfactory service, but the cost of running them is high, and there is always present the danger from fire or explosion caused by leaking gasolene. Also there is the danger of escaping carbon monoxide. The engines in the E and F classes are of the four-cycle Diesel type. These engines were built of too light construction, and so have never given satisfaction. The boats of the H and K classes also have Diesel engines, and these too, have given considerable trouble.

Contrary to popular belief, it is stated that the Diesel engines installed in the German submarines have not been any more successful than other types. The reason for their apparent success is that while some of the boats are on station, others are being over-

hauled at the yard so as to be ready to take the place of the others as circumstances require.

The French already have at least two large submarines fitted with steam power plants. In the United States an arrangement for the large sea-going submarines recently authorized has been proposed whereby two boilers using superheated steam furnish the steam for two turbines which are connected by suitable clutches to motor-generators. These, in turn, are also connected to the propeller shafts by clutches. By throwing out these latter clutches the motor-generators can be run independently by the steam turbines when it is desired to charge the storage batteries. When it is desired to run submerged the two forward clutches are thrown out, and the boat is then driven by the motors from the storage batteries.

The boilers used are similar to the flash boilers found in steam automobiles, and can generate steam very rapidly. Oil is used as fuel, and when the boat submerges, the oil supply is cut off, thus extinguishing the fires. The turbines can use the steam then remaining in the boilers for about ten minutes, and then the motors and storage batteries can be used. It is possible to secure with this form of steam plant an economy only a very little less than that of the Diesel engine. The weight for the same power will be less, also the temperatures and pressures are nowhere near as large as in a Diesel engine, thus greatly reducing the practical difficulties of design.

The storage battery is especially undesirable, but is an evil that apparently must be endured for the present at least. In addition to their great weight, these batteries occupy a large amount of valuable internal space, and are especially dangerous on account of their chemical contents. There are now two principal types of storage battery, viz., the lead battery and the Edison battery. The lead battery contains sulphuric acid, which, if it comes in contact with salt water, generates deadly chlorine gas. Also if this acid finds its way to the steel shell plating of the boat, it is liable to eat through, thus causing dangerous leaks, which may result in the loss of the boat, as in the case of the F-4, lost in Honolulu Harbor in March, 1915. The Edison battery is free from the danger of generating chlorine gas, but it causes the formation of hydrogen gas, which is explosive. A serious explosion, probably due to this cause, took place on the U. S. Submarine E-2 while at the New York Navy Yard not very long ago.

These and other troubles have led inventors to seek for some method which will do away with the storage battery and make possible the use of the same motive power for the surface and for submerged conditions. One method proposed is to use an internal combustion engine and an air compressor, the former being used to propel the boat on the surface, and also to run the air compressor. The compressed air is stored in flasks, and when the boat is submerged, the air is used to drive the internal combustion engine.

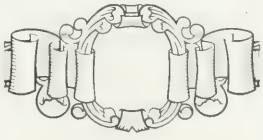
Another method is that due to the French engineer d'Equevilley. His system is now being tried in the French submarine "Charles Brun." The apparatus consists of an ordinary oil-burning boiler and a steam engine for surface propulsion. For the submerged condition the exhaust steam is delivered, just preparatory to submergence, into a special boiler containing caustic soda. The heat given off by the chemical reaction of the water and soda generates steam in this "soda boiler," and this steam can be used to run the engine.

When the boat comes to the surface, the water in the soda can be evaporated, and the soda can be used again for the next submerged run. This method has the disadvantage that the radius of action under water is somewhat limited, and also there is the danger of corrosion in the soda boiler.

The military features of the submarine of today are much more advanced than formerly. The number of torpedo tubes carried has increased from one or two in the early boats up to ten or more in the later boats. Also the size of the torpedoes now used is in most cases 21 inches instead of 18 inches. Submarines are now fitted with 3-inch and 4-inch rapid-fire guns, generally so mounted that they can be used aginst air-craft if necessary, and also arranged so that they can be stowed inside the hull very quickly when it is desired to submerge the boat.

According to some reports, the large German submarines have heavily armored conning-towers. This is a very desirable feature and made necessary by the fact that a submarine boat on the surface is generally an easy prey for a destroyer, or even a fast trawler or motor boat armed with one or two light, rapid-fire guns. If the periscopes are damaged when the submarine is running partially submerged, the boat must come to the surface sooner or later in order to take its bearings and open the hatches. Then, unless the submarine is armored, its thin sides can easily be pierced by shot from small-caliber guns.

It is believed that in the future submarine boats will carry much heavier guns and also will be well protected with armor. We will then have the submarine battleship or submarine cruiser, as the case may be, and instead of being confined to action on the surface, as are the large warships of the present time, those of the future will have the additional property of being able to run submerged whenever circumstances require.



THE HYDRAULIC RAM*

By B. H. ROBB, Cornell University, '11
Assistant Professor of Rural Engineering, New York State College of Agriculture at Cornell University

Editor's Note. Through the courtesy of *The Cornell Countryman*, published at Cornell University, Ithaca, N. Y., we are reprinting the following article. Mr. Robb has handled his subject in a very interesting and instructive manner. It contains information which should appeal to the technical student, no matter what branch of engineering he is specifically interested in.

THE hydraulic ram is an automatic device by which the fall of a comparatively large volume of water furnishes power to raise a part to a height greater than that of the source, by taking advantage of momentum and the inelastic properties of water. The original inventor was a man named Whitehurst, of Derby, a mechanic, who built his first ram about 1772. He had observed what is so familiar to most of us, that if water flowing through a long pipe with considerable velocity is suddenly stopped, a heavy rise of pressure is produced within the pipe, occasionally causing it to burst. Like Watt with his observations of the steaming kettle, it occurred to Whitehurst that advantage might be taken of this phenomenon.

If a small branch pipe is taken off the main near its lower end, a small quantity of water will be forced up this branch, to a height far greater than that from which the water originally fell. It is said that even though the Whitehurst ram was exceedingly crude and operated by hand, it was nevertheless actually used until about 1800, when Joseph Michael de Montgolfier, of France, devised a plan by which the Whitehurst ram was made automatic in its operation. This greatly added to its practical utility. The hydraulic ram of today, with only a few minor alterations for increasing its efficiency, is practically as Montgolfier left it. It is claimed that some of the rams of the original pattern as modified by Mr. Easton, who acquired from Montgolfier the British manufacturing rights, are still operating.

If simplicity were the only factor involved the hydraulic ram would be universally used, as it is mechanically the simplest self-contained pumping unit known. But unfortunately its use is restricted by certain physical conditions. In order to make use of this simple little machine, one must have an abundant supply of water in the form of a flowing stream with considerable fall. In other words, the major portion of the supply is used to force the minor portion to the point of utilization. There should be between the levels of the supply and the location of the ram a fall of three feet or more, although with a sensitive ram installed under favorable conditions this fall may be as little as two feet, and rams have been operated with a head of only eighteen inches.

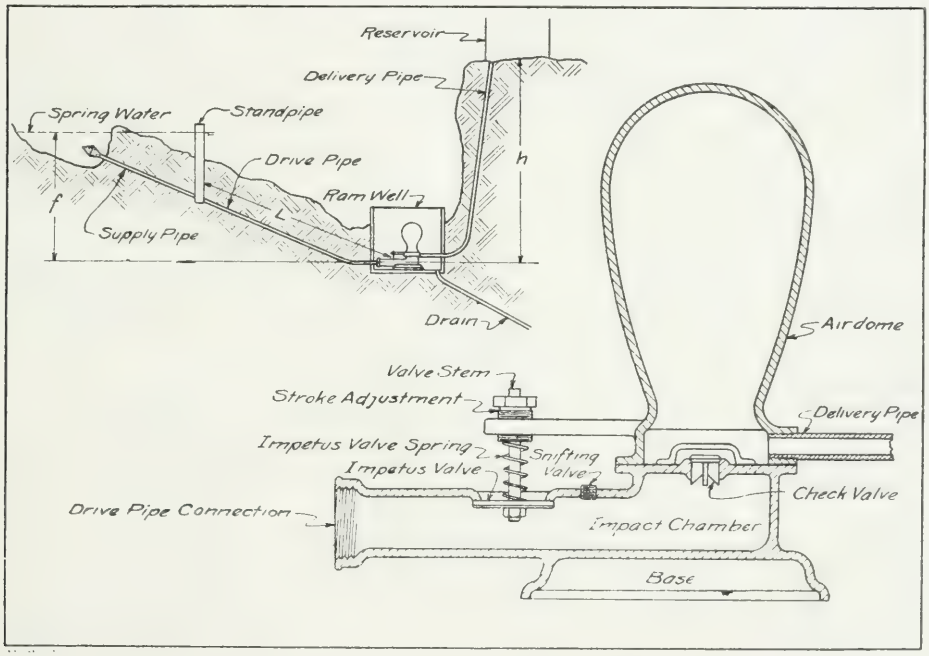
The actual height to which water may be lifted will depend on the supply head and on the design of the ram, some raising water only ten times as high as the supply head, while others will deliver to twenty-five or thirty times as high as the supply.

The amount of water raised depends on three factors—the distance the supply water falls, the height to which the delivered water is raised, and the quantity of water wasted. Within the range of practical operation the amount of water delivered will vary from as little as one-fifteenth of the quantity supplied to as much as one-quarter or one-third of that amount.

* Reprinted from *The Cornell Countryman*.

The principle of operation of the hydraulic ram is comparable to that of driving a nail into a piece of wood with a hammer. It would be impossible to push the nail into a piece of hard wood by means of pressing against its head with a hammer, but if the nail has been started and is then hit successive blows with the hammer it will be gradually driven into the wood. Hence the principle of the ram is that the water, by successive blows (made by its rushing impact chamber and the outer air. The former is a check valve, preventing water once in the air dome or the delivery pipe from returning to the impact chamber. The latter, called the impetus, or waste valve, is assisted in opening by a spring or a counterweight. The length of stroke of the impetus valve is usually adjustable.

The cycle of operations (shown diagrammatically in Fig. 2) of the hydraulic ram is as follows: The start is at A in

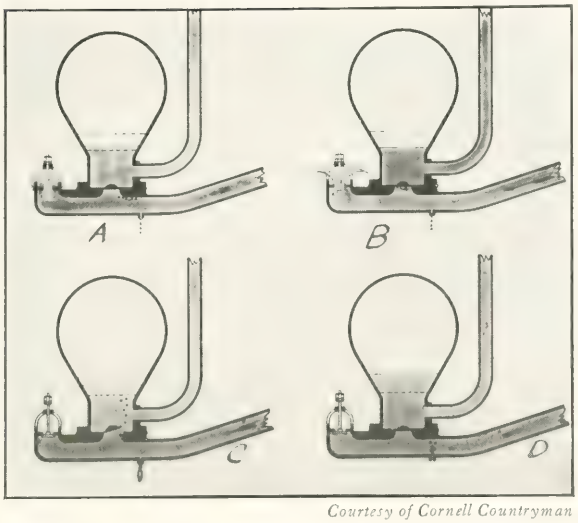


Courtesy of Cornell Countryman

Fig. 1. The simple hydraulic ram in cross-section

down the drive pipe), drives a portion of itself into the air dome and up the delivery pipe.

The essentials of the hydraulic ram (Fig. 1) are, a supply pipe, a discharge pipe, and a reservoir, or air chamber; the lower end of the supply pipe is enlarged to form the impact chamber. Besides these parts there are two valves, one between the impact chamber and the air dome, the other between the figure 2, with water flowing down the drive pipe into the impact chamber and out through the impetus valve, B, acquiring during this stage considerable velocity. Soon this velocity through the ram becomes so great that the impetus valve is carried shut (C, Fig. 2). Now water is incompressible; no steel bar could be more rigid that that mass of water coming down the drive pipe. It has no place to go to, and its inertia,



Courtesy of Cornell Countryman

Fig. 2. Diagrammatic representation of the ram cycle (Riley)

with terrific driving force, is expended against the closed impetus valve and against the valve leading into the air dome. As a result, since water is a fluid and free to move in any direction, it rushes rapidly into the air dome (D, Fig. 2) and is gradually brought to a standstill by the reaction of the confined air. This reaction is so determined that the inrushing water is not only stopped but is rebounded like a billiard ball from the cushion, sending the water backward along the drive pipe. This is indicated in the sketch (D, Fig. 2) by the arrow pointing in the reverse direction. This recoil of the water leaves a part of the space in the impetus chamber unoccupied; or, in other words, a partial vacuum is formed, under the influence of which the impetus valve drops open. The water recovers from the rebuff given it by the air and again starts flowing out at the open impetus valve. Since the valve in the air dome has been forced shut, the air pressure relieves itself by discharging water up the delivery pipe. Theoretically this is all that should be necessary for the ram to operate, but unfortunately the air in the air dome is gradually absorbed by the water and in a little while the cushion would be lost. In order to avoid this there is tapped in the base of the ram, as shown in the sketches, a little hole called the snifting valve. If we watch the action of the tiny stream spurting from the snifting valve we find that it is vibrant as well as intermittent, showing that the actions attending recoil are complex.

When the rebound comes and the partial vacuum forms, air slips into the impetus chamber (D, Fig. 2) through the snifting valve and is carried into the dome by the succeeding drive. Thus we have the ram cycle, and one of these little machines, if given a steady supply of water, will operate continuously, day in and day out, for years with but little cost or attention.

When installing a ram it is very important to protect it and the drive and delivery pipes from freezing (Fig. 7). Usually a small pit or well is built, in which the ram is located. A sufficient drain should also be provided to remove the waste water, as flooding reduces the efficiency of the ram. A ram will work under water, however, provided there is a net fall in the supply.

By the law of conservation of energy, the quantity of water entering the ram multiplied by the distance of fall should equal the quantity of water delivered by the ram times the distance raised. If we let f equal the fall in the drive pipe, h equal the delivery head, Q equal the quantity of water supplied by the reservoir, and q equal the quantity of water delivered, this fundamental expression would be:

$$Qf=qh$$

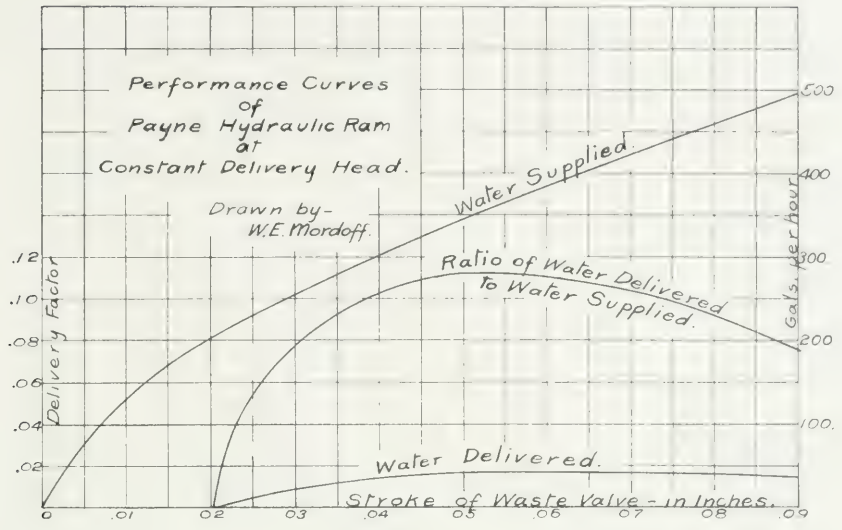


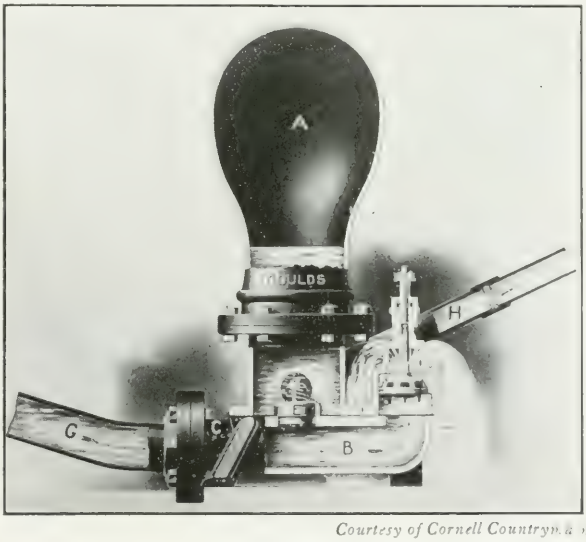
Fig. 1. Courtesy of Cornell Countryman

Unfortunately, however, friction losses in the pipe and imperfections in the ram prevent this formula from holding true. In computing the capacity of an actual ram we must correct the ideal equation by introducing a correction factor, which is really the mechanical efficiency of the ram. Putting the corrected expression into words, we would say that the water supplied times the distance of fall times the mechanical efficiency of the ram equals the water delivered times the distance raised; or, if k equals the correction factor, then

$$Qfk = qh$$

$$\text{or } q = Qfk/h$$

In practice k equals from 60 to 66 per cent.



Courtesy of Cornell Countryman

Fig. 3. Section of hydraulic ram showing valves and chambers.

A, air dome; B, impact chamber; C, shifting valve; E, air dome check valve; F, impetus valve; G, drive pipe and delivery pipe.

The inertia of the moving column of water in the drive pipe is very great. If the drive pipe is very long, it is possible for this inertia to be too great for the valves and the working situation of the ram. There is a fairly definite relation between the length of drive pipe and the head on the ram. The following formula for determining the proper length of drive pipe is deduced from one more complex given by the Rife Hydraulic Engine Company:

$$L = \frac{h^2}{f}\left(n - \frac{.002}{f}\right)$$

in which $n=0.12$ when h/f is 10 or less, and $n=0.08$ when h/f is between

10 and 20; when h/f is more than 20 this formula does not hold. So far as we know this formula is purely empirical.

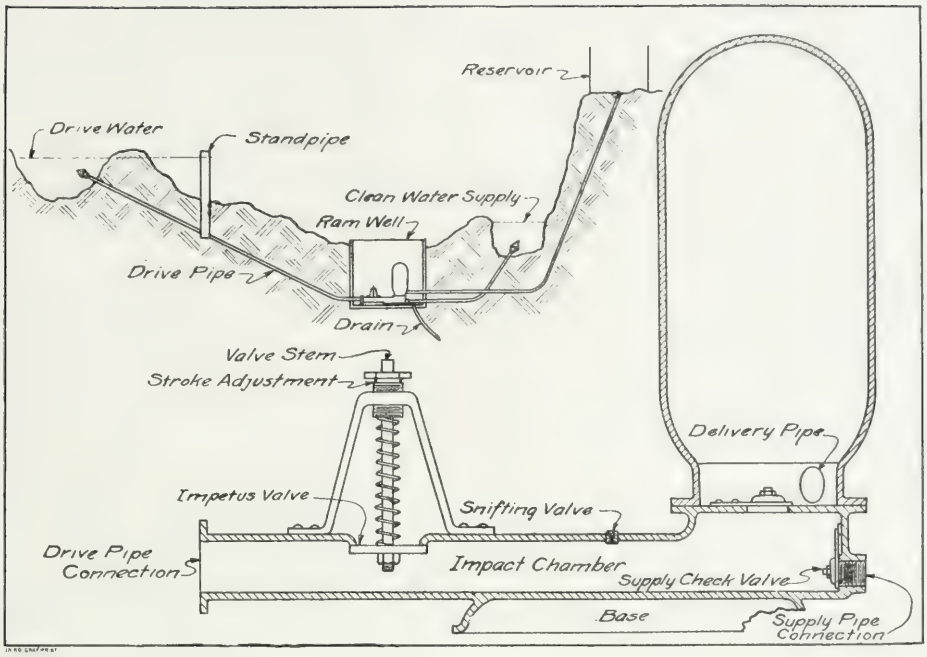
Should it be found that the length of drive pipe is less than the distance from the supply necessary to secure proper fall, a standpipe is placed in the supply line (Fig. 1). The purpose of this standpipe is to maintain the head but shorten the driving column to the proper length; therefore it must be an open-top pipe, rising slightly above the level of the supply.

Courtesy of Cornell Countryman

Fig. 5. A hydraulic ram pumping from a spring to a gravity tank

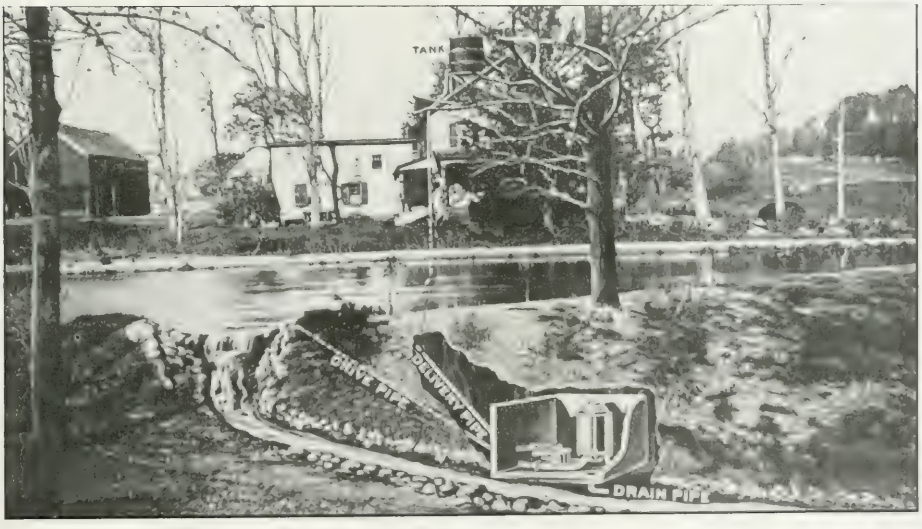
The operation of a ram is regulated by varying the length of the impetus valve stroke. Shortening the stroke increases the number of impulses per minute. The performance of a typical ram operating under fixed heads but with varying lengths of stroke is represented in a set of three curves, shown in figure 4.

For abscissa we have length of impetus valve stroke. The ordinates are gallons of water per hour on the one hand, and delivery ratio on the other. The first curve is called the water delivered curve. It is the amount of water that the ram actually delivers for the various lengths of stroke. On a very short stroke the ram delivers no water, merely maintaining the pressure; therefore this curve does not pass through zero. The second curve, showing the amount of water used, represents the quantity of water which flows into the ram—part to be wasted, part to be delivered. The third curve is obtained by dividing the water delivered by the water supplied for each length of stroke. This curve is interesting in that it shows at what stroke we get the most water delivered in proportion to the water supplied to the ram. It will be noticed that this curve rises very rapidly to a maximum and then gradually falls away. Now, if we either shorten or lengthen



Courtesy of Cornell Countryman

Fig. 6. The double acting hydraulic ram



Courtesy of Cornell Countryman

Fig. 7. A hydraulic ram pumping from a stream to a gravity tank. The necessary supply head obtained by means of a dam

the stroke from this point of greatest efficiency, we get less water in proportion to the amount supplied; if we lengthen the stroke we use more water and deliver more, but if we shorten it the reverse is true.

These curves tell us also that if our supply of water is small it is best to set the ram for the largest delivery ratio. If, however, the quantity of supply water is unlimited, we can afford to lengthen the stroke and get more water delivered at a greater expense in waste. Should it happen that our water supply is so limited that we cannot set the ram for the high point on the ratio curve, it would be much better to get a smaller machine.

The hydraulic ram is generally used to pump directly into a tank (Fig. 5) from a stream or a spring, in which case the head pumped against is nearly constant. It is possible, however, to pump directly into a pressure tank; if this is done, care must be taken not to draw the pressure down too low, as great range of pressure is likely to stop the ram. No particular damage will be done, but one must go down to the ram and start it again.

It sometimes happens that one has a spring emptying into a stream. It is desired to have the spring water pumped to the house, but the supply of spring water is so limited that there is not enough to waste through the ram in order to do the pumping. By making use of the double-acting ram (Fig. 6), the energy of the creek water may be used to force the spring water to the point of utilization.

The double-acting ram works on exactly the same principle as the single-acting ram just described. There is one additional feature, however. Water from the clean supply enters the impact chamber and passes toward the open impetus valve, while the dirty water from the drive pipe is already flowing out at this valve. When impact occurs, the clean water, being nearer the air dome check and prevented from returning the way from which it came by the supply check, is forced into the air dome. The extent of mixing of the two waters is determined by relative heads of respective supplies, size and shape of impact chamber, and length of impetus valve strokes. In order that the impact chamber may fill promptly, an auxiliary tank or standpipe is placed in the clean water at a considerable distance away with the supply head low. This arrangement greatly reduces the extent of mixing. The only requirements for successful operation of the double-acting ram are that both sources of supply be higher than the ram. If the clean water has greater head than the dirty water, the loss of clean water through the impetus valve will be considerable.

THE WIND TUNNEL OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

By J. S. HUNSAKER, U. S. N., S. M.

Assistant Naval Constructor, United States Navy Instructor in Aerodynamics, M. I. T.

Editor's Note. This part of Mr. Hunsaker's article is the conclusion to the article that was commenced in the April, 1916, issue of *The Technology Monthly* and *Harvard Engineering Journal*. From the many favorable comments on the first part of the article we feel gratified in our selection of Mr. Hunsaker as one of our authors.

Determination of Wind Direction in the Horizontal Plane

As a first approximation, the wind was assumed parallel to the axis of the tunnel. A vertical flat plate was mounted on the balance arm and carefully set parallel to a line drawn on the floor of the tunnel in the direction of its axis. The plate was inclined 8 degrees to right and left of this position and the transverse force measured on the balance. The observations were repeated for 6 degrees and for a second plate to eliminate errors due to irregularities in the plates. The transverse force on one side was greater than on the other, indicating an error in the assumed wind direction. A new line was drawn on the tunnel floor, making an angle of 0.3 degree with the original line. The observations for transverse force were repeated. It was found that the average of transverse force readings taken for equal angles to right and left of mid-position differed 0.5 per cent from the mean of all readings. The extreme error of one observation, including the error of 0.5 per cent due to lack of sensitivity of the balance and the personal error of the observer, may then be as great as 1 per cent, in case the two errors are cumulative.

It is not considered practicable to obtain a closer setting with the methods of alignment employed.

Setting Arms of Balance

Knowing the true direction of the wind, it is necessary to set the horizontal arms of the balance parallel and perpendicular to this direction. To do this the floating part of the balance was rotated by an adjustment provided by the design until the force was recorded on the "drift" arm (the resistance) was equal for equal angles of the plate to right and left of the wind direction. The final setting indicates a remaining error of 0.2 per cent.

After making the slight adjustment required here the error in the transverse force measurement was not found to be increased.

Measurement of Air Velocity

The velocity of flow in the wind tunnel is measured by a pressure tube anemometer commonly called a double Pitot tube.

Our laboratory standard is a double Pitot tube presented by the director of the National Physical Laboratory, England. This tube was compared with the National Physical Laboratory standard which had been calibrated on a whirling arm by F. H. Bramwell. Its constant has been determined to be unity to a precision of 0.1 per cent. Our tube was compared with it by a method allowing

a precision of 0.25 per cent. A discrepancy of about 0.25 per cent was found. Its readings may then be taken as correct to this degree of precision. In all cases a uniform rectilinear current is implied.

The Pitot tube, in common with all anemometers, has the disadvantage of obstructing the channel, and where models are to be tested the channel should be kept entirely clear. The expedient of using a side hole in the channel is due to M. Eiffel.

In a channel of uniform section, the air is forced to flow practically parallel to the axis of the channel. Hence stream lines are all parallel and across any section, taken normal to the channel axis, there should be no component of velocity at any point. This statement is of course true only for a steady, uniform flow free from turbulence. The static pressure should be constant across a section, for if pressure differences existed there would be a transverse flow of air created. Tests in our wind tunnel showed constant pressure across a section to a good approximation. Incidentally the constancy of this static pressure across a section is a measure of the uniformity of flow.

A small hole in the side of the tunnel can then be used to measure the static pressure, but the dynamic pressure measured by the impact end of the Pitot tube is

$p + \frac{pv^2}{2g} = p_o$, by Bernoulli's equation,

where p=pressure at any point in a stream line.

v=velocity at any point in a stream line.

σ=density at any point in a stream line.

p_o=pressure where v is zero.

In our wind tunnel a fan sucks air through the tunnel, which is therefore all under suction. The air is discharged by the fan through a strainer into the building at one end, whence it returns at a low velocity to the other end, to pass again into the tunnel. At a point in the room the pressure transmitted by an impact tube would be

$$p_r + \frac{pv_r^2}{2g} = p_o$$

But the room is 30 times as large as the section of the tunnel, and when a wind of 30 miles is blowing in the tunnel there is only a gentle draft in the room of about 1 mile per hour. Thus, the ratio $\frac{v_r^2}{v^2} = \frac{1}{900}$ and the pressure in the room can be taken as

$$p_r = p_o = p + \frac{\sigma v^2}{2g}$$

neglecting v_r^2.

If, then, we connect a hole in the side of the tunnel with one end of a liquid manometer, and leave the other end open to the room, the gage reading is proportional to the difference in pressure, or to

$$p_r - p = p_o - p = \frac{\sigma v^2}{2g}$$

The reading of the manometer thus is a measure of the velocity.

Due to loss of head from friction in the mouth of the tunnel and in the honeycomb, the relation

$$p_r = p + \frac{\sigma v^2}{2g}$$

is not strictly true. An unknown loss in friction would be represented by adding a term to indicate the friction head pressure. Then

$$p_r = p + \frac{\sigma v^2}{2g} + p_f$$

The use of the side plate method ignores the effect of Pf. A comparative test showed an error of 3 per cent when the velocity was calculated from side plate readings. It is, therefore neces-

sary to calibrate the side plate and its manometer against the standard Pitot tube and its manometer.

The side plate consists of a thin brass disk about 3 inches in diameter set flush in the wall of the tunnel. The disk is flat and highly polished. Near its center, five holes, 0.02 inch in diameter, are drilled. These holes are connected with a brass tube soldered to the back of the plate and projecting through the side of the channel. Rubber tubing is used to transmit the static pressure from the small holes to one end of a manometer. As explained above, the other end of the manometer is open to the air in the room.

The pressures transmitted by the side plate is read on an inclined alcohol manometer on the Krell principle. Both the side plate and this alcohol manometer require calibration against a standard. For convenience, the side plate and its manometer were calibrated together against the Pitot tube and a Chattock manometer.

The standard National Physical Laboratory Pitot tube was mounted in the center of the tunnel in the place where models are tested. This tube was connected to the Chattock gage. The side plate in the wall opposite the tube was then connected to the alcohol gage. The wind speed was then adjusted to 2, 4, 6, 8, etc., up to 40 miles per hour and both gages read. Some 100 readings were taken. From the Chattock gage readings the true speed was taken from its calculated curve (for standard air). The readings of the alcohol gage were then plotted on true speeds. The curve so made was then a calibration of the side plate and alcohol gage in combination. The Pitot tube and Chattock gage may now be removed, and in future model testing the alcohol gage readings may be used to measure the velocity at the center of the tunnel.

It can be shown that the velocity over the section varies about 1 per cent over a 2 foot 6 inch square at the center of the tunnel.

J. FANZ STAUB AS HELENE ANGEL
IN "M 31"

"M 34"—ITS PURPOSE AND ITS DEVELOPMENT

By O. R. FREEMAN, M. I. T., '16

Editor's Note. Tech Show has always been a success from a theatrical as well as a financial standpoint. True, it has evidenced the formula type that Mr. Freeman speaks of—yet what present day musical comedy, professional or amateur, is not of this general type—its success lies in its manner of production, its interpretation, rather than in its plot.

This year someone conceived the idea of giving the public something distinctly different from former Tech Shows. The type of show was changed, not because previous performances made such a change necessary, but because Tech likes to be different and original. Mr. O. R. Freeman and Mr. R. H. White are the co-authors of "M 34."

THE scientific mind is inclined to apply its methods of systemitizing to all matters with which it comes in contact. Whether due to this tendency or dictated by custom, Tech Show has gradually developed into a formula production. Like any musical comedy of the present, there was the inevitable hero, heroine and villain, a little conversation, an explanatory introduction, a tangle, a denouement and a "lived happy ever after" ending. The scenery always consisted of an interior and a wood scene, or an elaborate and a more simple wood scene. A ballet and a chorus broke in at stated intervals and sang about anything that the lyric writer happened to think about. Everybody went and everybody came away admitting that they had seen good amateur acting.

Tech stands for progress. It stands for ideals. It stands for all that is highest and best in the educational world and why should its annual show be content with sinking into mediocrity. Interested alumni, earnest advisors and a wide-awake coach saw the opportunity for Tech to do something new in the field of college dramatics. When scenarios came in this year they were of the formula type and were immediately thrown into the discard. Tech with its men and its training was called upon to produce a show and Tech responded.

Men whom the management thought capable of sketching a scenario for the new, and as yet, unnamed, type of play were picked from the candidates who attended the meetings called for the purpose. Ideas were gathered, arranged, rearranged and shaped into a plot.

In developing the plot the writers sought to give the audience something local, something entertaining, something which would bring into active interest the maximum number of men, and above all, something which would eliminate as far as possible the formula characters and the coarse-voiced maidens.

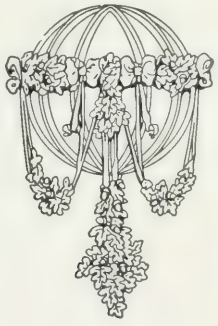
The scenario completed, all those interested in scenery were called in and a sympathetic interpretation of the scenes developed. To these men the play was read and the character of the scenes outlined. They then set to work and turned out whole series of preliminary sketches which were criticized, corrected and re-studied. Finally accurate, detailed, scale models were constructed and these set up in miniature stages in order to ascertain the proper depth of the masking pieces and the possibilities of various lighting effects. It is from these models that the final scenery has been painted.

J. PAUL GARDNER AND WALTER A. WOOD
IN "M 31"

The settings determined, those who had ideas on costumes were assembled and devised costumes in harmony with the settings. While the study of costumes may seem a simple matter, the amount of actual labor spent in studying the various color combinations, the effects of different lights and the chances of color groupings can hardly be imagined. These various problems had to be carefully solved before the design of the costume itself could be started. It was finally found necessary in order to obtain a desired color effect in a material which could be properly draped for certain costumes to have the material all dyed to order. It is such problems as these that the layman does not know of or appreciate in his casual résumeé of the performance. At this point the show scored its highest point as an all Technology production by the Co-eds asking that they might sew the costumes.

The scenery was to have been done by the students, but the rapidly rising cost of materials prevented, and the management found in Robert Brunton, builder for the famous Urban of the Follies, Pom Pom, Around the Map, and other musical comedies, a man wonderfully capable of undertaking the work. Under his guidance the scenery designers have been introduced to many of the technical mysteries of the art, and have had the opportunity of watching the vague imaginings of their intellect take form under the hand of a master.

So Tech presents to you a show, the product of not only all Technology, but of the scientific mind that can see beyond a formula opportunity for new ideas, new methods and ideals, interpreted by a splendid cast, a wonderful and well trained ballet, a competent orchestra, and filled with the spirit of Technology.



LITERATURE AND THE TECHNICAL STUDENT

By ROBERT GORDON SHAND, M. I. T. '17

Editor's Note. Possibly the average technical student *does* neglect literature. Maybe the case at Tech is for the average man as Mr. Shand points out. At all events, the following article is food for thought. Are YOU the Tech man referred to?

"IF a girl sits out a dance with a fellow who doesn't give her the look of a slightly bewildered cow when she slings a little Swinburne at him, but who lets fly the tail end of a Rossetti sonnet in return, closely followed by a gem or two purloined here and there from Henry James, she thinks," says C. M. Flandrau in *Harvard Episodes*, "that she has met another of those typical Harvard men." I have sometimes wondered whether that "slightly bewildered cow" expression is supposed, on such occasions, to be typical of the Tech man.

Now, as a matter of fact, the average scientific student reads a certain amount of non-technical matter; some of them read a great deal. Not every student has been enslaved as a youngster by the office-boy-to-bank-president inanities of certain types of juvenile books. Yet how many, as they have grown older, have developed their literary taste correspondingly with their growth along other lines? The vital question is not "How much does the scientific student read?" but rather, "What does he read?" Just as the reading of worthwhile literature has a broadening, stimulating effect upon him, and develops his powers of thought, appreciation, and expression,—so the reading of trash has a degrading influence upon him, impairs the memory, makes the intellect flabby. It is a far cry from the trash of the moment to Henry James.

Literary taste, in reality, is largely a matter of training. To many a lad of ten there is no sound so sweet as that of a hurdy-gurdy: some mundane souls there are who in a lifetime never learn to prefer anything better. The same is true of reading. Yet a man's happiness and usefullness depend, to a certain extent, on his attitude toward literature. I know men who find in literature a keen, enduring pleasure; who seem to enjoy it as some men enjoy a good cigar. To them literature is a vital thing: they feel the throbbing humanness of it. Books are among the most living things they have about them, and the sight of a carefully chosen library fills them with satisfaction. An appreciation of literature means to them an appreciation of the world and the best that is in it; an understanding of literature brings to them an understanding of the world.

And not only that; literature seems to heighten their capacity for pleasure. They see more of the world, love it more. They come to realize that the world is not such a dull place, after all. Far from being a mere accessory literature is, in their minds, a fundamental to complete living. Interest in literature is no perfunctory polish with which they gloss themselves on occasion; they get up with it in the morning and go to bed with it at night. They look upon it as a means of life, and in learning how to use this means of life, they have formed their literary taste. As for those who shun living a full life—who are averse to experiencing feeling, emotion—literature is not for them: the yellow primrose still does duty by the river's brim.

A man's happiness and usefulness, I have said, may, to a certain extent, depend upon his attitude toward literature. Now what is the attitude of the scientific student? A widely varying one, it seems. There is the extremist, the worshipper of the practical, whose manner seems to say, "You and I are practical men." Just as in Harvard's *Music* 4 we find some who affect a languorous pose, so at Tech, with the swinging of the pendulum in the opposite direction, we meet the over-practical student, who says with bland complacence, "Why I know little of literature." And as for poetry, it seems quite the code for the budding engineer to know nothing about it. He is wary of it: he eyes it with askance. Poetry, forsooth, is silly and effeminate, and an engineer is, of course, concerned with the things of men. He is a builder of bridges—big, powerful steel structures, while a poet,—why, he is only a builder of verses. By far the commonest point of view, however, is that of the scientific student who looks upon literature as a purely cultural study,—as something of which, like music and painting, it is well to have a smattering for dinner conversation. To this student, literature is a thing remote, detached,—an abstraction to which he may deprecatingly refer as "not in my line." But when is he to begin to dip into literature? When is he to stop regarding literature as an abstraction and get hold of it in the concrete? Well, perhaps later, when he plans to take up the violin and Spanish. Meanwhile he steers clear of English classics and turns with gusto to that "rattling good story" in the current issue of a popular magazine.

The engineer, I have said, is concerned with the things of men. Is not the writer of literature? The builder of bridges, the builder of books,—each must see a vision. And sometimes there comes a poet who dreams a dream of the things of the engineer. Has not Rudyard Kipling culled romance from the most sordid things of every day? He has found a whole world of romance in engineering. He has sung the arts of peace, no less than those of war. These songs of peace tell of the discipline of the most menial trades, the most prosaic business of life, and of the division of labor among men. If the young engineer would stop to analyze Kipling's militarism, he would perhaps find it resolving itself into a worship of discipline and obedience to duty,—essential to all efficient work and service. Here he would find much to inspire him, much to make him a better engineer. He would choose Kipling, of course, for a "starter," because, as the cant expression goes, "Kipling grips hard." If once the habit be acquired, the student will soon find himself extending his reading. Gradually there will be established, between author and en-

gineer, a bond of sympathetic understanding, until one day the young man will start up from his reading with the exclamation, "Isn't that true! How often I've thought that very thing myself!" He is surprised at himself. He has made a discovery; literature is not an abstraction: it is life. And therefore it is true. The erstwhile warped, narrow technical student is no more. Unconsciously he begins to feel with the Greeks: "Everything in proportion, nothing in excess." Books are becoming his "pals." Enjoyment of literature is no longer a faint, perfunctory accomplishment: it is one of the fundamental facts of his life. For him, literature is "an interpretation of life", a kind of mirror which enables him, when he turns from the printed page to the world itself, to see in life the truth and beauty which might otherwise have remained hidden from him. He sees clearer visions, dreams nobler dreams. And therein he has become a wiser engineer.

SOCIAL ENGINEERING AS A VOCATION

By HAROLD E. AKERLY, M. I. T., 1910

Editor's Note. Every day the business world has new problems with relation to the employer and employee. Every day there is an increasing demand for men who can satisfactorily solve these problems. Such things are bound to come into the life of the Tech Man sooner or later. Mr. Akerly, who is doing work along these lines for the Eastman Kodak Company of Rochester, N. Y., is especially fitted to write on this subject, and here gives us a splendid idea of the field and demands of such work.

ALL engineering is social. As has been said many times, without the developments wrought by engineers the life of man today would be on a far lower plane than it is. In some engineering work the effect upon man is remote, in other branches of engineering it is immediate. Only within the last few years, however, has the latter type of engineering been consciously developed, and but recently has the engineer himself given serious thought to the immediate effects of his work upon the lives of men.

A few years ago, in one of our famous industries, a designer built, at a cost of many thousands of dollars, an automatic machine which handled three operations formerly done by hand. Despite its mechanical excellence, the machine failed to operate economically because the physical demands made upon the operator were too heavy. With two operators the cost of manufacturing was higher than by hand. The machine was not a success until it was redesigned so as to lighten the operator's work. This instance is but one of several in the same plant.

There are two general reasons why the engineer today is considering his relation to other men in carrying on his work. The first is that the successful engineer is enabled, by the broader general training which he is receiving, to take voluntarily a deeper interest in the social and economic problems of the day; the second is that mechanical equipment in competitive industries has become so standardized that the advantage to be gained by one manufacturer over another by mere excellence of mechanical equipment is often less than the advantage which he can secure by developing his personnel to the highest point of efficiency. The manufacturer, therefore, has often placed his engineers upon social as well as upon technical problems.

As soon as the great importance of the human factor in industry became apparent, many ways of developing the productivity of the working man were devised by industrial engineers. The pioneer workers in this field took the working man as they found him, and, by the aid of scientific time and motion studies, developed his productivity to a much higher point. This work is growing and broadening from year to

year as the possibility of its wider applicability becomes apparent. The field for this type of engineering is not restricted to industry, however, but has extended even to medical practice, a noted motion study expert now being employed on the problem of standardizing operating methods in hospitals.

Very recently it has been discovered, however, that while productivity is largely increased by properly instructing all workers, maximum productivity cannot be secured by merely teaching workmen who happen to be working at a certain operation. To secure the best results, the worker must have the proper physical qualifications for his work, and more important, his mental attitude towards his work must be right. In other words, the men must fit the jobs. In order to secure the right man for the right job, scientific employment methods have been developed.

While employment managers were selecting the right men for the right jobs, and production engineers were developing these selected men to what appeared to be the highest point of efficiency, other engineers discovered that there was a huge loss both to employee and employer in the fact that the workmen were constantly losing time from their work, a considerable number as the result of injuries, while others were suffering from occupational diseases. A third group was working irregularly because of poor housing or other domestic or outside conditions which affected their work.

In addition to the loss to both employer and employee due to irregularity of attendance, there was the loss chargeable to irregularity of employment. Large numbers were quitting and the length of service of the average employee was short. The so-called labor turnover was high. This meant a large drain upon industry, because not only does the workman lose by continually changing his job, but the cost to employers is huge. For example, a few years ago a large rubber company hired over twenty thousand men in one year to maintain a pay roll of seven thousand. As experts figure that it costs from $25.00 to $100.00 to hire a new man, the loss to this plant can be seen at a glance.

In order to cut down accidents, which brought not only a burden of pain and poverty upon the employee, but cost employers and society as a whole as well, the safety inspector was evolved. He was recruited from the ranks of the shopmen, from the office and from the engineering department. As the importance of this work has become impressed upon the great employers, not only because of an awakening consciousness of their obligation to their employees, but also because of certain statutory requirements in the workmen's compensation laws, the employers and the insurance carriers have dignified the job of safety inspector and have called it "safety engineer." Upon the safety engineer of a company is placed the responsibility of making the plant and its equipment safe, and the further and more important duty of instilling the gospel of safety into the minds of the working men and their families, for it is a fact that far more accidents are caused by unsafe practices than by unsafe working conditions.

To eliminate occupational diseases and to improve many of the physical conditions in workshops, the sanitary engineer has been called in. Very often he co-operates with the company's physician, who is engaged in reducing the amount of sickness among the employees, and with visiting nurses or

male investigators working in the homes of the working men. The latter in one large automobile plant are called "domestic engineers."

To eliminate the economic loss due to irregularity of employment, the labor expert has been developed. He studies among other things: problems of employment; the education of the mechanic or working man so that he will fit his job; and methods of encouraging employees to long service, such as wage dividends, bonuses and employees' suggestion systems. He cooperates of course with the efficiency and other engineers whose work directly affects the workmen.

In a trip through the large plants of the country, one will meet technical graduates working in all of these newer fields, as fire prevention engineers, safety engineers, employment managers, heads of corporation schools, directors of welfare work, and of course as efficiency engineers working on time and motion studies. These men are all social engineers, for to be successful they must be able to co-operate with and retain the friendship of the persons for whom and with whom they work, as well as the employees upon whom the results of their work fall. As an experienced time study man said a few days ago, ninety percent of our success is dependent upon the ability to get along with the employees.

To the technical graduate there has been opened, therefore, within the past few years a wide new field of work among the great industries of the country. That technically trained men are well adapted to solving these personnel problems, or, putting it differently, to be social engineers, is proven by the large number of college graduates successfully doing this work.

THE AMERICAN INTERNATIONAL CORPORATION

A TECHNOLOGY INSTITUTION

By CHARLES A. STONE, M. I. T., '88
President of the M. I. T. Alumni Association
President of the American International Corporation

Editor's Note. The present world-wide war has caused most thinking Americans to consider what position our country will occupy in the future world's commerce. Mr. Stone here tells what a group of prominent men are doing, many of whom are Tech Men, to advance America's interests, as well as your interests, as future engineers. This article originally appeared in the Stone and Webster Journal.

THE opportunity is here today for undertaking to bring this country in touch with other parts of the world in a way that has never before been possible, and I want to tell you in a few words a little of what this may mean to the Massachusetts Institute of Technology and its Alumni.

London has been for generations the financial and commercial center of the world, but at the moment she needs assistance, England, France, Belgium and Russia are all calling upon us for help at this time. We have become a rich nation and have as yet only partially developed our own internal resources.

To assist in the development of these resources, and at the same time to hold out a helping hand to the other nations of the world, is the essence of great opportunity which now presents itself to us. After this war is at an end, all the nations involved will need help, and the time is ripe for us to organize in order that we may be able to become as effective as possible in assisting these countries in their need. This should be done upon lines which will establish permanent and friendly relations with all countries.

The jealousies bred by commercial rivalry were partially the cause of the present great conflict, and in consideration of our own future welfare we must plan to develop our commercial relations in such a way as to secure the friendship rather than the hostility of the people with whom we deal. To attempt to accomplish this a few years ago would have seemed chimerical, but I believe the present world crisis has made the possibility of this very thing practicable.

South America was largely financed in England; Russia in France. Belgium formerly financed many undertakings in different parts of the world, but is helpless now. All of these nations need to establish further credit in this country to pay for supplies, and beyond that they will need further capital for the development of the various enterprises in which their people are interested. All this requires money, and the conduct and development of great undertakings require judgment and skill of the highest order.

It is an unfortunate thing for the countries involved in this war that the loss of life to all nations has been relatively larger among the officers and skilled men than in the rank and file. It is now a war of wits rather than a war of brute force, and after it is all over, the nations which have participated will find themselves short of skilled men trained for commercial and industrial enterprise.

Here is where we will find an opportunity, but we must be prepared and equipped to act promptly, for the war

is teaching all those involved in the struggle the value of discipline and resourcefulness, and they will be quick to recover.

The great question is—how can we best use our skill and our money and render a service to the foreign nations and ourselves as well?

The answer, I think is this:

1st—We must furnish capital for the rehabilitation of works that have been destroyed and for the further development of enterprises not only within the countries at war, but in those countries outside of the war area, which are being largely financed and promoted by the present participants in the struggle.

2d—We must furnish immediately trained engineers and men skilled in commerce and arts to take up the work in countries such as Russia, South America and other parts of the world, which was formerly being done by trained men of the warring nations, who have now been called to the front.

3d—We must furnish material, supplies and machinery to supply the needs of countries whose industries are prostrated.

4th—We must supply ships and means of transportation.

5th—We must aim to proceed along these lines slowly and cautiously, with the purpose in view of establishing relations with the various nations, which will not only be helpful to this country in developing our resources, our industry and our skill, but will, as far as possible, lead us into permanent and friendly relations with our neighbors.

This, gentlemen, is a task of the greatest magnitude; but if it can be taken up on broad lines with the view of establishing permanent relations, and not in a spirit of greed, the United States will become an example to the world as the leader in a much needed reform.

The foreign universities—especially the German universities—have accomplished marvelous results in turning out trained and efficient men capable of effective accomplishment, and these universities also assisted in working out the problems of the manufacturers.

The Institute of Technology has done something of the same thing, and can develop the work further along the same lines. The Tech has today some 2000 students, and about 11,000 members in its Alumni Association. I believe these men are as well trained and efficient as any similar body of men in the country, and with the equipment and facilities of the new Technology we should be able to turn out men who will develop into the most highly skilled engineers, constructors and entrepreneurs that the world has known.

Now, the point which I wish to make is that with the opportunities which are now open for industrial expansion, there comes also a greater opportunity than ever before for our graduates in foreign fields. They will be needed, and if they go in the right spirit they will be welcome.

Americans today are doing much that it is impossible for the people of other nations to do in the war zone. In Belgium, an American engineer, with a large force, mostly Americans, has succeeded in organizing a system of distribution of food and supplies that is commended alike by both the German and Belgian nations which are involved in a bitter struggle with one another. American surgeons and medical men have done much effective service in France. Dr. Strong, an American medical expert, who got much of his experience in foreign countries and in the Philippine Islands under Governor Forbes, went to Servia some months ago and (with a force which he organized of about 200 men—many of whom were

Americans) he practically eradicated the typhus epidemic which was dealing death to the Servians by the thousands, and ingratiated himself and our nation with these people.

In all these examples which I speak of, the Americans have been most welcome in the foreign fields. Of course, these were works of humanity. Commercial undertakings are more difficult because the spirit of jealousy and competition interferes; but with the right men going in the right spirit, the opportunity is now open; and for the engineering undertakings that are required, I know of no body of men better suited than the members of this Alumni Association.

COMPILING TECHNIQUE

By JOHN M. DeBELL, M. I. T., '17
Editor-in-Chief of Technique, 1917

Editor's Note. Every college publishes, in some form, a year book. At Tech, as in many colleges, the honor of the publication of such a book is entrusted to each succeeding Junior Class. The responsibility of getting out a good book is upon this Class, but aside from this, *Technique* is, in the broadest sense, an all institute affair.

A STOCK declaration of each Technique Board is to the effect that "this year's book is the best ever." It is not inordinate conceit which inspires this claim; nor is it wholly due to the logical assertion that each volume is able to include all the good features of its predecessors. It is, rather, a natural result of a year's labor in attacking and overcoming obstacles of every conceivable nature. A body of undergraduates, in the beginning almost totally inexperienced with regard to their particular task, show a pardonable pride at the completion of a volume which has grown under their eyes and at their own hands.

The difficulties which they have to meet are by no means confined to those arising from inexperience, as a few typical examples will show. In order that these may be properly understood, they may well be enumerated in connection with an explanation of the organization board.

The departments this year have been as follows: the department of the Editor-in-Chief, which for want of a better name is designated as "General"; the Business Department, headed by the Business Manager, who is aided by two assistants; the Finances Department, which is the exclusive domain of the Treasurer; the Art Department, consisting of the Art Editor and four assistants; and the Portfolio, Grind, Statistics, Athletics, Photograph, Faculty and Societies Departments.

The Business Department, as its name indicates, handles the advertising, executes all contracts, and incidentally carries on all correspondence with the engravers. This last is not entirely devoid of humor. The following are extracts from a letter from the engravers after they had lost some valuable copy.

" . . . We are all pretty much human, you know, and we think from your letter that you are equally so . . . We are hoping you will still be sufficiently human so that you will be as kindly indulgent as we are inclined to be by reason of our advanced years and wider experience with the frailties of human nature." Meanwhile, the "frailties of human nature" were bluing the atmosphere as the presses waited, and the rush replacement of the same copy became one of the pleasantries of the Art Department, requiring about twenty consecutive hours' work.

The Athletics Editor is the archaeologist of the Board. He digs up records which have hitherto been successfully concealed from even the prying reporters of the Tech, and is often compelled to settle arbitrarily the conflicting "positively accurate" assertions of disagreeing authorities. He is supposed to be both a sporting writer and litterateur, a combination seldom attempted.

For the Societies Department, an ideal head would be an ex-clerk of the dead letter office. A large number of societies, to be sure, hand in lists which can be sent to the printer after checking, but others submit veritable messes of

copy, on which the names must be entirely rearranged, initials looked up, and everything rewritten, previous to checking. The prize insert this year came in written in lead pencil on some old scraps of wrapping paper.

The Faculty Editor must be diplomatic. His duty is to set a time and place for each of the faculty group pictures, and then to wheedle from every professor and instructor a promise to be present. In the performance of this work, he occasionally hears very decided opinions regarding the place of student activities at an engineering institution.

Probably the greatest amount of routine work falls on the Societies, Statistics, and Portfolio Editors. For example, the Statistics Editor has the esthetic job of checking the general directory, containing two thousand names and addresses, with the written attendance cards and the catalog, of which the former is frequently incomplete and the latter wrong. The most thankless task of all is allotted to Portfolio Editor. He starts out in September to get three things from every prospective Senior—a formal photograph, a snapshot negative, and a brief biography; after having obtained these, he writes up and later checks the section. When he has once completed the Portfolio, he is willing to swear that the Seniors are the most inordinately modest (if nothing worse!) humans in existence.

Thus are indicated some of the ways and means, as well as meannesses, of compiling the yearbook; but progress from year to year is hampered chiefly by the inexperience resulting from the discontinuity of Boards. Unless radical changes are effected, this obstacle will continue to exist as long as Techniques do; and as long as it does exist, errors of commission will occur in the book. The one advantage of the system at present is not for the volume, but for the individual members of the Board; for their year's labor cements an intimate friendship and frank fellowship which more than compensates for the time and energy they have expended. Whether or not the book is actually "good," they derive not merely valuable experience, but also the enthusiastic confidence that comes from putting heart and soul into a mutual work.

ENTROPY OF SOCIALISM

A REPLY TO H. F. GOLDSMITH'S "ENTROPY OF CIVILIZATION"

By EASTMAN A. WEAVER, M. I. T., '15

THE analogy which Mr. Goldsmith pointed out last month between things human and things thermodynamic is an extremely apt and far-reaching one; and in pointing out a limitation in one phase of his point of view, I do not wish to be understood as detracting from the very great value of this point of view as a whole. Mr. Goldsmith shows very clearly how the levelling process as applied to humanity means a loss of available human energy, just as in the case of water seeking its dead-level, or of heat becoming unavailable at constant temperature. He proceeds, however, to accuse socialism of aiming to promote this levelling, and of seeking as its goal a state of dead equality among mankind.

That this is the very antithesis of

the Socialistic ideal is not generally realized, because Socialism does stand for a superficial equality—an equality in one respect only,—equality of opportunity. A great many Socialists regard the uniform restraints which Socialism would impose as only an intermediate step in leading up to a state of affairs in which no restraints shall be necessary. Even those who do not go as far as this, advocate levelling only in the sordid, foundational economic sphere, so that no individual may be unfairly hampered in his full development of higher qualities, or in his attainment of more worthy ambitions. They would remove false economic differences only in order that genuine differences, physical, mental, and moral, may stand out in their true dimensions.

Going back to our thermodynamic and hydrodynamic analogies, we see that every case of energy-dissipation involves two factors or components, one corresponding to the quantity of flow, and the other to the frictional resistance opposing this flow. Thus there are two ways of minimizing dissipation,—first by shutting off the flow, and second by making the flow free and frictionless. Only the first seems to have been considered by Mr. Goldsmith; he would maintain differences of level by freezing up Niagara. Socialists, on the other hand, are striving to conserve available energy without imposing on humanity any such artificial stagnation, by making the rise and fall of individuals frictionless and unhampered. Here analogy fails, as there are no frictionless fluids in nature; but the removal of dissipation in this way would lead to an infinitely wider range of possibilities in the way of level-differences, in a mobile and spontaneous, instead of a hard-and-fast and artificial, process of development.

In just this way, Socialists aim to prevent, not genuine differences among mankind in the things that really count, in authority, responsibility ,public respect, self-respect; even in legitimately earned leisure and personal belongings. The most radical idealists among them desire to remove only forced and artificial inequalities of economic position, based not on the genuine qualities of the individual, but on the accident of parentage and on the possession of sordid and grasping characteristics such as all true men and women look upon with disgust. Capitalism sees no other possibility of maintaining differences of level than by an ingrowing economic system which places certain fortunate (or unfortunate) individuals arbitrarily above their brothers and maintains them there irrespective of their true deserts.

This discussion is of course wholly on the desirability of the Socialistic ideal, not on its feasibility of application. Practical Socialists admit that a far-reaching change in the molecules of humanity, as well as in its social structure, must precede the frictionless state. But they do not on this account give up hope of accomplishing this change by a steady process of education and character-development.

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All Positions are open to competition.

All manuscripts submitted for publication in the TECHNOLOGY MONTHLY AND HARVARD ENGINEERING JOURNAL should be accompanied by the writer's full name and address. Manuscripts not accepted for publication will be returned only if the author so requests. Photographs, drawings, etc., will be returned to the contributor immediately after publication.

Forms close the 28th of the month immediately preceding date of publication. Material specially arranged for may be received up to the fifth day following.

EDITORIAL

THE NEW BOARD

THE Outgoing Board of Directors of The Technology Monthly and Harvard Engineering Journal takes pleasure in announcing the election of the following men for the coming year: Editor-in-Chief, Linwood Irving Noyes, of Marinette, Wisconsin; Business Manager, Richard Henry Catlett, of Staunton, Virginia; Managing Editor, Frank Charles Howard, of Haverhill, Massachusetts; Advertising Manager, Robert E. DeMerritt, of Reading, Massachusetts; Circulation Manager, Joseph H. Stagg, Jr., of Bridgeport, Connecticut; Treasurer, William L. Dennen, of Gloucester, Massachusetts; Publicity Manager, Edwin F. Rossman, of St. Louis, Missouri; Art Editor, L. Franklin van Zelm, of New Rochelle, New York; Staff Photographer, Frederick H. Norton, of Boston, Massachusetts; General Staff, Henry F. Goldsmith, of Philadelphia, Pennsylvania; Benjamin I. Lewis, of Lynn, Massachusetts; Marvin M. Stetler, of Dallas, Texas; G. Wells Root, of Hartford, Connecticut; Robert K. Wells, of Winthrop, Massachusetts; Frederick M. Barnicoat, of Quincy, Massachusetts; and Donald B. Winter, of Fall River, Massachusetts.

One of the great benefits a student gets from service on the Monthly is an appreciation of, and participation in a successful, efficient, and effective organization. During the past year the history of our internal affairs has been one of complete harmony and co-operation, such as can only come with the belief that our magazine has an important and ever-increasing field to fill.

This field we believe to be that of making Technology and Harvard students and alumni broader and better-informed men than they would otherwise be. It is only by this that the New Technology can continue to hold her supremacy in Engineering and Science. The increasing success of The Technology Monthly and Harvard Engineering Journal insures this superiority.

For the New Board's spirit of good-fellowship, and for their efficient and faithful work as assistants, we wish to express our appreciation to these men, upon whom the responsibility of publication now rests.

By the Outgoing Board of Directors,

MAURICE F. BRANDT, *Editor-in-Chief.*
RAFAEL ALFARO, *Business Manager.*

THIS Junior Week is a fitting climax to a year of exceptionally successful undergraduate activity. Individually and collectively activities have prospered. This has been best shown, perhaps, by the way each class has responded as a unit to its various dinners, smokers and the like. Many attendance records

have been broken. Each activity has prospered in accordance with this general wave of spirit, interest and energy. Co-operation has been in evidence everywhere.

Junior week is the culmination of this endeavor; the combination of Institute activity. Let's ALL join in and have a good time.

A NEW library has been started for the Walker Memorial. This library will be unique in that it will be formed from the books recommended by the alumni and professors who understand the kind of books which will be of interest to Institute men. This selection will include the recent publications of authors who are noted for original thinking, and who interest the people of America by their style. Dean Burton, Professor Pearson and Dr. Mann have already made recommendations. This month, books recommended by Mr. Bemis, Professor Merrill, and Dr. Gordon will be placed in the general library.

"TECHNOLOGY Preparedness" is progressing. The Engineering Corps is now an established and permanent thing. Evidently there is a sense of realization of the fact that that the country needs men. With the dreams and plans of a Summer vacation which usually accompany Spring, why not plan on Plattsburg, or some time on a Summer Naval Training Ship? Some day the call may come. You are the men who will be called. Let's be ready!

HARVARD GRADUATE NOTES

'81—Howard Elliott, President of the New York, New Haven & Hartford R. R., was the principal speaker at the annual banquet of the trust company section of the American Bankers' Association in New York City on February 25.

'99—Langdon Pearse is practising hydraulic and sanitary engineering with Samuel A. Greeley, '03, at 64 W. Randolph St., Chicago.

'00—R. B. Bedford has opened in New York an American branch of R. S. Stokvisen Zonen, Ltd., of Rotterdam, Holland, under the firm name of R. S. Stokvis Zonen, Inc.

'00—R. R. Rumery has recently been appointed consulting engineer for New York City.

'02—Carl A. Sylvester was married on January 20th to Miss Lillian Foster Harrington in Newton, Mass. Mr. and Mrs. Sylvester will live in Rio de Janeiro.

'03—Samuel A. Greeley has opened an office for practice as hydraulic and sanitary engineer, at 64 W. Randolph St., Chicago. He has made two trips to Europe and one to Caracas, Venezuela, to investigate sanitary conditions.

'06—Henry L. Lincoln, formerly assistant refrigerating engineer for the Commonwealth Edison Co., of Chicago, is now engineer for the Frost Maker Ice Machine Co., a concern which makes refrigerating machinery for home and store use. His address is 140 S. Dearborn St., Chicago.

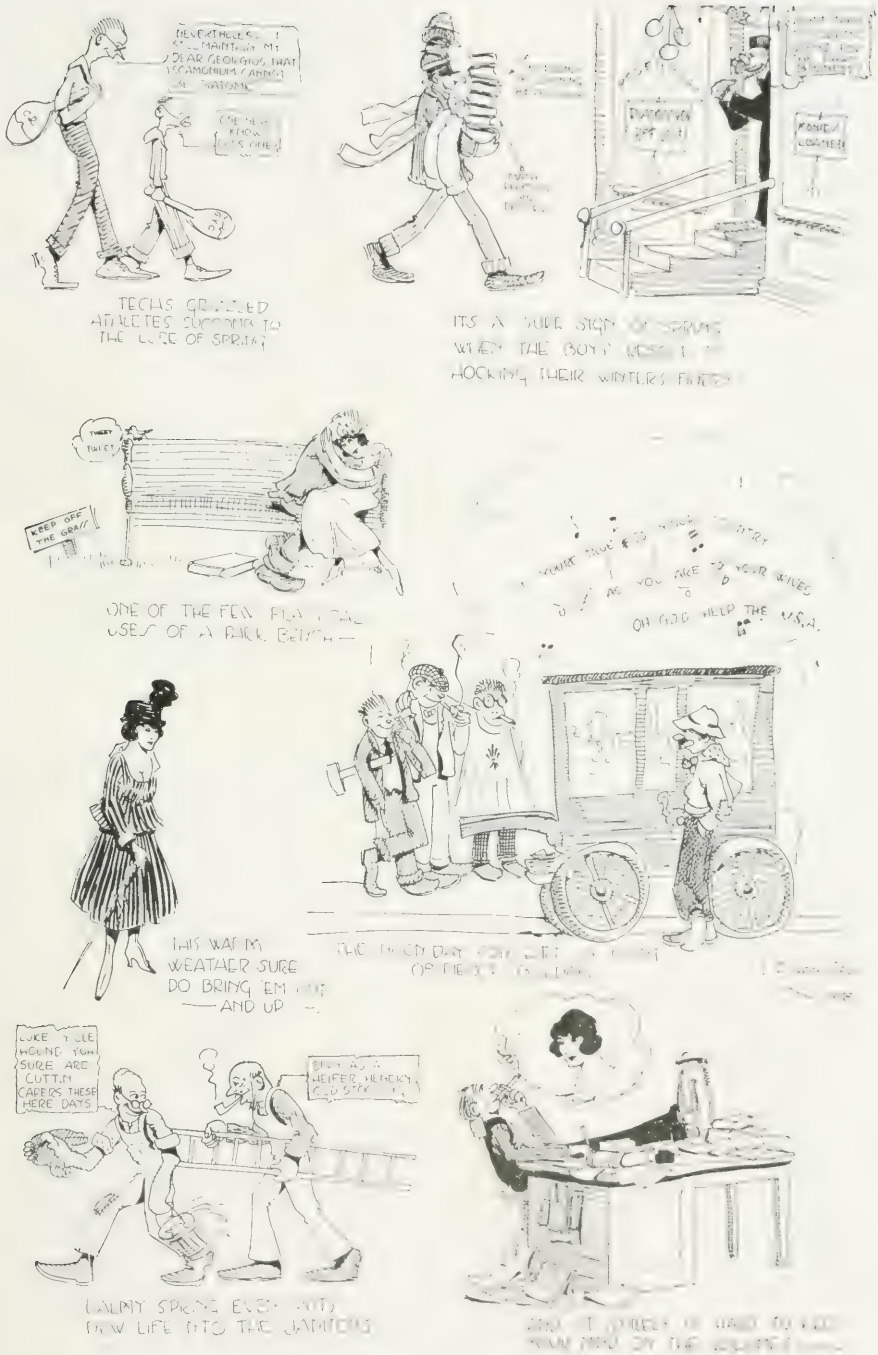
'09 Frank P. Huckins was married on February 2, at Nashua, N. H., to Miss Florence H. Ramsey. They will live at 36 Berkeley St., Nashua, N. H. Huckins, who is President of the P. S. Huckins Co., 40 Central St., Boston, has been elected a director of the Metropolitan Trust Co. of Boston.

'10—Gustaf S. Bohlin is doing railroad valuation work for the Interstate Commerce Commission. His present address is 417 Irving St., N. W., Washington, D. C. His permanent address remains 138 Lexington Ave., Cambridge, Mass.

M. E. E. '10—Charles A. Wright, who has been with the American Telephone & Telegraph Co., in New York City, has been appointed Associate Professor of Electrical Engineering at Iowa State College. His address is 517 Ash Ave., Ames, Ia.

'12—J. H. Perry, Jr., of the Pennsylvania Lines West of Pittsburgh, is pilot engineer for the Federal Valuation of Common Carriers at Louisville, Ky. His address in Louisville is care of the Y. M. C. A.

WHEN YOUR GIRL GOES IN RAPTURES OVER THE HANDSOME DEVIL OF A HERO —
FAIR LOUISE - (TO DANCING PARTNER WHOSE UNREQUITED LOVE HAS CAUSED HER DRESS) - WON'T YOU PLEASE PUT YOUR HANDKERCHIEF ? - AND HE DID!
MASCULINE GRACE AND DEXTERITY AT THE THE DANCE
HANK 1918
WHEN YOU FIND YOUR ROOMMATE COMING WITH YOUR GIRL JUST AFTER YOU VERY DECENTLY HAVE AVOIDED US
WHEN YOU REMARK WHAT A POOR DANCER SHE IS, NOT KNOWING THAT YOU ARE SPEAKING TO HER PARTNER
THE PLEASANT REALIZATION THAT YOUR TICKETS TO THE ATHLETIC MEET RECLINE SAFELY ON THE MANTLE PIECE

EMBARRASSING MOMENTS DURING JUNIOR WEEK

TECHS GRIZZLED ATHLETES SUCCUMB TO THE LURE OF SPRING
ITS A SURE SIGN OF SPRING WHEN THE BOYS BEGIN HOCKING THEIR WINTER'S FINES
KEEP OFF THE GRASS
ONE OF THE FEW PLAUSIBLE USES OF A PARK BENCH
OH GOD HELP THE U.S.A.
THIS WARM WEATHER SURE DO BRING 'EM OUT —AND UP—
LUKE YULE HOUND TUH SURE ARE CUTTIN CAPERS THESE HERE DAYS
CALMY SPRING EVER AND NOW LIFE INTO THE JANITORS

SIGNS OF SPRING

SERVICE SATISFACTION

Our guests are our recommendation:
and that is why the

HOTEL LENOX

has won an enviable reputation for being
Boston's most homelike hotel

BACK BAY STATIONS L. C. PRIOR, MANAGER

HARD TO GET ALONG WITH

"Hard to get along with, isn't he?"

"Oh, yes. He is as quarrelsome as a pacifist."—Kansas City Star.

"Say, Claude, did you get your shirt back from the laundry?"

"Yes, Reginald, but not the front."—Longhorn.

"Yes, I told father that the white poker chip I dropped was a peppermint tablet."

"Did he swallow it?"—Hobart Herald.

Hayes (in 1920)—We do all our cooking by electricity here.

Customer—Take this egg out and give it another shock.—Yale Record.

HIGGINS'

DRAWING INKS
ETERNAL WRITING INK
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THE BARBER SHOPS AT
THE COPLEY-PLAZA Boston
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She was a careless girl to put the subscriber on the wrong number. Being in a hurry, the subscriber promptly asked for a box for two.

"But we don't have boxes for two," said a startled voice at the other end of the line.

"Why, isn't this the theatre?" he inquired.

"No," was the reply. "This is—— the undertaker."—Exchange.

HE OUGHT

"Is she a brunette?"
"No, she's very light."
"Are you sure?"
"I ought to know. I picked her up."
—Dartmouth Jack-o-Lantern.

EVENING UP

"You've had plenty of rain in your section?"

"Yep. Hurt my crops, too."

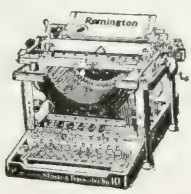
"Will you lose much money?"

"No, I'll break about even by hauling autos out of mudholes."—Pittsburgh Post.

Rube (reading program) — "'Four Hours elapse between the first and second acts'. I'll be goldinged if I'll wait that long!"

Carrie—Molly's crying because she can't get her Latin.

Harrie—Poring over her work, eh? —Stanford Chaparral.



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American Writing Machine Company
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TECH SHOW 1934

BOSTON
OPERA HOUSE
Saturday May 6
2 P.M. and 8 P.M.
MALDEN - - May 11
8 P.M.

"That's a fine suit you have there. What is it?"

"A dynamo suit."

"How's that?"

"It's charged."

Bones—How does Stecker throw so many men by the scissors hold?

Maxey—By shear strength.—Awgwan.

'19—I managed to get drunk on cider last night.

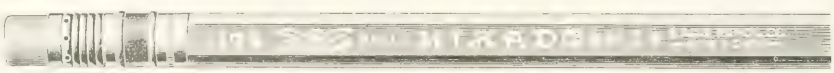
'16—You must have found it rather hard.—Harvard Lampoon.

It—You ought to be good at geometry.

Thing—Why so?

It—Your head is both plain and solid.—Widow.

EAGLE "MIKADO" PENCIL No. 174



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5c EACH OR 50c PER DOZEN
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CONCEDED TO BE THE BEST PENCIL MADE FOR GENERAL USE
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4 THINGS

are assured by your early order

No. 1 Security against advanced prices in clothes — an advance in a short time as sure as you live.

No. 2 Procuring foreign dyed woolens — **by looking ahead** — we can offer an entire and large stock of such woolens.

No. 3 Better workmanship before the "rush reason" is on.

No. 4 A larger stock from which to make your choice.

BURKE & CO., Inc., Tailors

1256 Massachusetts Avenue (Harvard Square), Cambridge
18 School Street, Boston

Poke—How did you come to lose so much money?

Kerr—I didn't come to lose.—Illinois Siren.

QUELQUE FILS

Derbies brown have I worn, God wot!
Suits of a green abhorred.
My life is a dark and dismal blot,
But I never made jokes on a Ford!

With purple ink my letters I pen,
I eat like a human blight,
—But I never read "La Parisienne"
Or bellow, "Drunk Last Night!"

Yale Record.

She—Did you know that ankle watches have become all the rage?

He—Yes, so I see.

She—Oh, you horrid thing! You can not!—Widow.

At registration—Where were you born?

Maiden—Nebraska.

Clerk—What part?

Maiden—All of me, of course.

—Awgwan.

Him—I have a friend who suffers terribly with the heat.

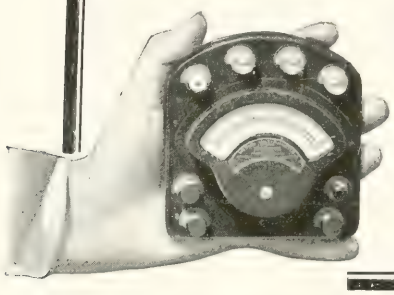
Her—Where does he live?

Him—He isn't living.—Lehigh Burr.

Weston

MINIATURE PRECISION D. C. INSTRUMENTS

The same degree of mechanical and electrical excellence which has won pre-eminence for the larger Weston Models is embodied in these wonderful little masterpieces of the instrument maker's art. The finest watch is a less striking example of perfection in refined workmanship. They are accurate, dead-beat, extremely sensitive. They are shielded against external electrical and magnetic influences. Despite their great refinement in workmanship, they are very substantially constructed and have the longest scale ever provided in instruments of similar size. In short, they are the finest development of small instruments of the pivoted moving coil, permanent magnet type. And the prices are low.



The group includes Portable Volt-Meters, Millivoltmeters, Volt-Ammeters, Ammeters, Mil-Ammeters in single, double and triple ranges; Battery Testers, and Switchboard Voltmeters, Volt-Ammeters, Ammeters and Mil-Ammeters. The several models and ranges offer a selection from over 300 different combinations.

The switchboard instruments are listed in bulletin No. 20, and portable instruments in bulletin No. 501. They will be mailed on request.

Weston Electrical Instrument Company

69 Weston Avenue, Newark, N. J.

New York	Chicago	Detroit	Montreal
Boston	Cleveland	St. Louis	Toronto
Philadelphia	Cincinnati	Denver	Winnipeg
Buffalo	Richmond	San Francisco	Vancouver
	Pittsburg		

UNSYMPATHETIC

"Sir, your daughter has promised to become my wife."

"Well, don't come to me for sympathy; you might know something would happen to you, hanging around here five nights a week."—Houston Post.

"Pa, a man's wife is his better half, isn't she?"

"We are told so, my son."

"Then if a man marries twice there isn't anything left of him, is there?"—Boston Transcript.

"Isn't that my umbrella you have there?"

"Most likely—I just bought it in a pawnshop."—Punch Bowl.

HER COMEBACK

Evangeline—How do you like my new hat?

Caroline—I think it is charming. I had one just like it last year.—Philadelphia Evening Ledger.

A SUITABLE MATCH

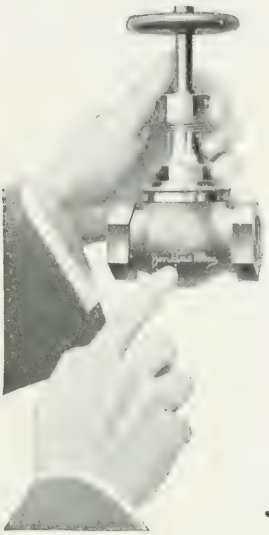
"So you think Katherine made a very suitable match?"

"Yes, indeed; you know what a nervous, excitable girl she was. Well, she married a composer."—Tit-Bits.

Cob—"Nothin' doin' in the news line today, boss."

Editor—All right; put a pair of trousers on the office cat, photograph him, an' we'll run a special on the oldest living American Indian."—Puck.

Jenkins Bros.' Valves



Always dependable. Interchangeable in every part. Parts can be duplicated and replaced even where valves have been in service for years. In most cases the simple renewal of the disc (inexpensive and easily inserted) makes the valves as good as new. Jenkins Bros. Valves last longer, give less trouble, and are less expensive in maintenance than common metal-seated valves.

Jenkins Bros. Valves have trade mark as shown in the cut

JENKINS BROS.

New York, Boston, Philadelphia, Chicago, Montreal, London

LOTS OF WILL

Fumes I'm going to quit smoking.

Tombs—You haven't the power.

Fumes—The devil I haven't. Why, I've quit four times already this month. —Chaparral.

"When You Wore a Tulip and I Wore a Big Red Rose" is a most beeootiful song, but to say the least we were scantily clad.—Widow.

"My face is my fortune, sir," she said.

"In that case," he returned with a courtly bow, "I presume that your inheritance tax was not excessive." —Widow.

"They say these architects are lay dreamers."

"Yes, they work at night."

"Why haven't you been to see John since he's got water on the knee?"

"I'm afraid if he holds me on his lap I'll get seasick."

Harney—George Washington threw a stone across a river and extablished a record that has never been beaten.

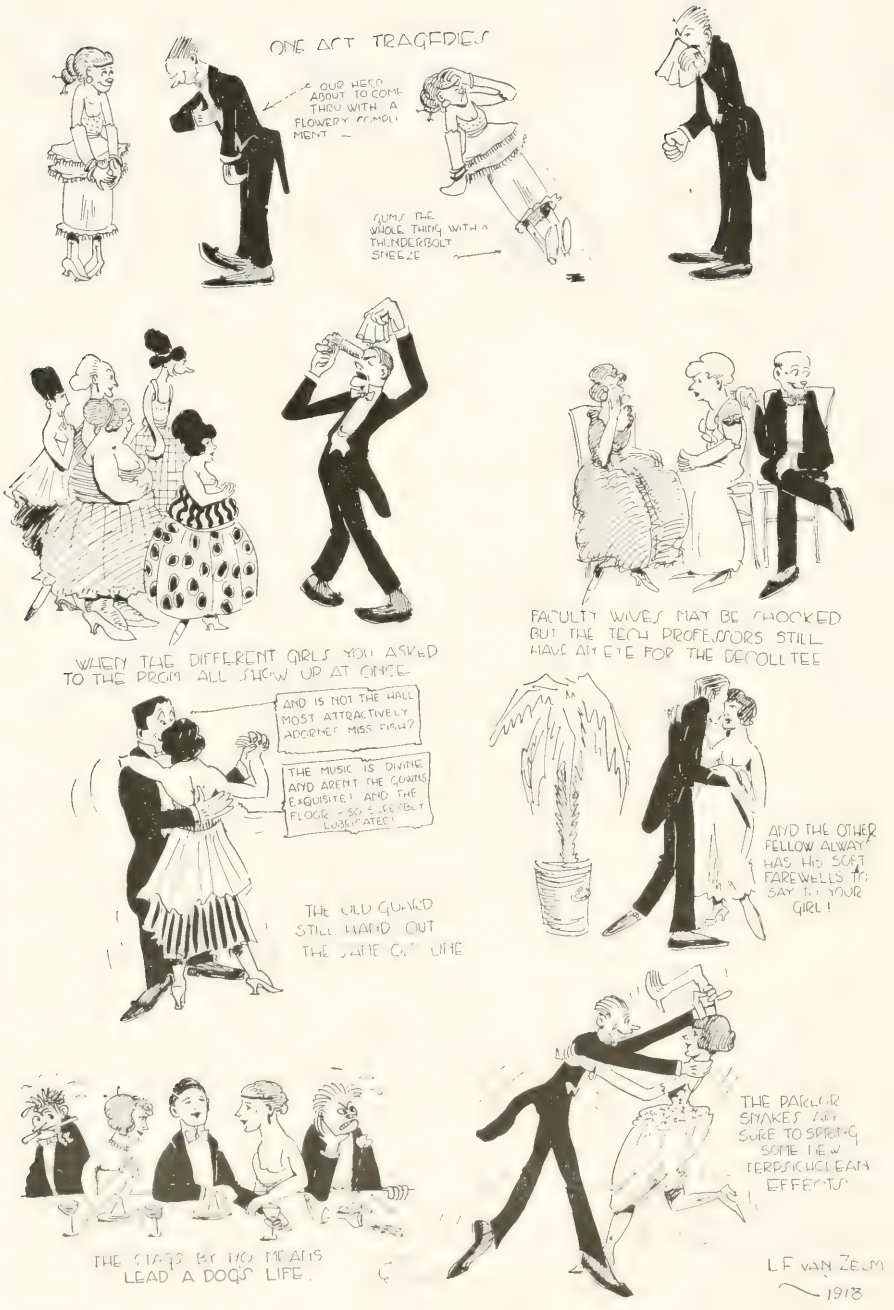
Eldridge—It was a dollar he threw.

Harney—What difference does it make?

Eldridge—A dollar would go farther in those days.—Awgwan.

"Say, pa, this book says 'the royal coffers were empty.' What's a royal coffer?"

"A king with consumption, my son."

(And they journeyed eastward.)—Williams Purple Cow.

ONE ACT TRAGEDIES
OUR HERO ABOUT TO COME THRU WITH A FLOWERY COMPLIMENT —
GUMS THE WHOLE THING WITH A THUNDERBOLT SNEEZE
WHEN THE DIFFERENT GIRLS YOU ASKED TO THE PROM ALL SHOW UP AT ONCE
FACULTY WIVES MAY BE SHOCKED BUT THE TECH PROFESSORS STILL HAVE AN EYE FOR THE DECOLLTEE
AND IS NOT THE HALL MOST ATTRACTIVELY ADORNED MISS FISH?
THE MUSIC IS DIVINE AND AREN'T THE GOWNS EXQUISITE! AND THE FLOOR - SO EXCEEDINGLY LUBRICATED!
THE OLD GUARD STILL HANG OUT THE SAME OLD LINE
AND THE OTHER FELLOW ALWAYS HAS HIS SOFT FAREWELLS TO SAY TO YOUR GIRL!
THE STAGS BY NO MEANS LEAD A DOG'S LIFE.
THE PARLOR SNAKES ARE SURE TO SPRING SOME NEW FERRSICHCLEAN EFFECTS!
L F van Zelm
1918

STUNTS THAT ARE SURE TO HAPPEN AT PROM

THE HOURLY OCCURANCE IN HER BOUDOIR
DON'T TELL YOUR 'LOIDY" TOO MANY PRETTY THINGS — SHE'S SURE TO GAB IT TO THE REST OF THE GIRLS
GIRLS AREN'T ALWAYS THE SEDATE CREATURES WE PICTURE THEM TO BE — EVEN THE CHAPERONE ENJOYS AN IMPROMPTU FANNA PARADE-
AND BOYS! IT'S BEST TO LOCK YOUR DESKS-, GIRLS WILL BE CURIOUS

INSIDE DOPE, BOYS; THE GIRLS AS THEY REALLY ARE ON YOUR HOUSE-PARTY

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He—Good heavens, the clock just struck one, and I promised your mother I'd leave at twelve.

She (comfortably)—Good! We've eleven hours yet.—Yale Record.

EXPLAINING IT

"I think I can explain it to you. Now, I ask you for a kiss. That's the initiative."

"And I refer you to mother."

"Um. That's the referendum."—Louisville Courier-Journal.

She—Belle won't let John marry her until after he graduates.

He—Why so?

She—She's afrai.d he couldn't get his Bachelor's Degree —Tiger.

STRENGTHENING THE MEMORY

Algie—My memory is getting weaker every day.

Reggie—I can give you a remedy.

Algie—What is it?

Reggie—Lend me fifty dollars.—Yale Record.

Kelly, '19—Know her?

Pool, '19—Nope.

Kelly, '19—Neither do I.

Pool, '19—That's queer. She seems to know us!—Purple Cow.

DAMNING DESCRIPTION

She—What's he like?

He—Oh, he's the kind of a fellow that counts the cigarettes in a box.—Yale Record.

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SEASONABLE

She—One robin doesn't make a spring.

He—Nor does one swallow make a fall.—Gargoyle.

He—When is a joke not a joke?

She—Well?

He—Usually.—Wisconsin Awk.

Morrie—Gee, what a conceited cuss!

Freckles—What's the matter now?

Morrie—You think you can write as well as I can.—Jester.

"Quick, Watson, the needle," chuckled Sherlock Holmes, and he slowly wound up the Victrola again.—Jack O'Lantern.

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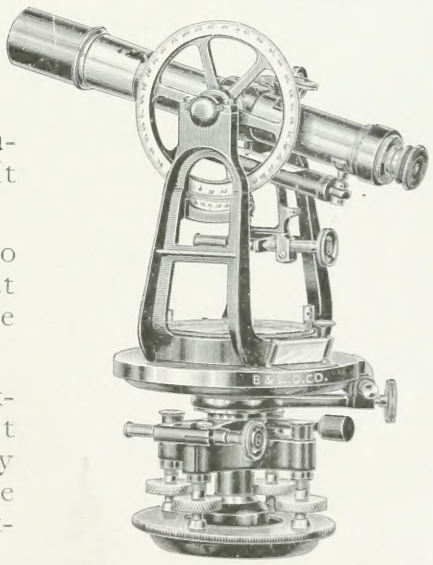

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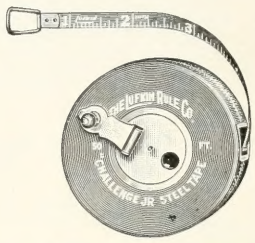

"I heard my son last night praying. He said, 'Good bye, God, I'm going to Tech.' "

"He meant, 'Good, by God I'm going to Tech!' "

"I hear that Bill is going out West for his health."

"Is he? How did it get out there?"

—Penn. Punch Bowl.

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